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# Landscape Pattern Associated With Mexican Spotted Owl Habitat in Capitol Reef and Zion National Parks

# LANDSCAPE PATTERN ASSOCIATED WITH MEXICAN SPOTTED HABITAT IN CAPITOL REEF AND ZION NATIONAL PARKS

**FINAL REPORT**

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# LANDSCAPE PATTERN ASSOCIATED WITH MEXICAN SPOTTED OWL HABITAT IN CAPITOL REEF AND ZION NATIONAL PARKS

## INTRODUCTION

Wildlife managers and land-use planners are commonly faced with management conflicts among sensitive wildlife species, their habitat, and human related activities (Verner et al. 1986). An early step in biological conservation is the identification of critical habitat that, once set aside, can be managed for long-term viability of a threatened or endangered (T&E) wildlife population (Shaffer 1985). Because a species' distribution can extend over a large and potentially complex management area, designation of critical habitat is not an easy task.

Geographical Information Systems (GIS) are now recognized as important tools for mapping and modelling potential Habitat Conservation Areas for sensitive species (Murphy and Noon 1992). By overlaying an animals known distribution with land cover types, land ownership, and topographic themes (e.g slope and aspect data), models describing critical habitat can be produced relatively quickly over various spatial scales (Murphy and Noon 1992). A GIS can analyze geographical data over larger areas with more variables than is typically possible with traditional (noncomputerized) manual methods (Shaw and Atkinson 1990).

The spotted owl (*Strix occidentalis*) has been the focus of agency and public concern in the Pacific Northwest for over a decade (Salwasser 1987). In that region, the Northern subspecies (*S. o. caurina*) is associated with mature, multi-layered forests

(Carey et al. 1990, Franklin et al. 1990), and is declining throughout its range because timber management practices have negatively impacted its habitat (Gould 1977, Forsman et al. 1984).

Little information is available concerning habitat use of Mexican spotted owls (*S. o. lucida*). This subspecies occurs in forested highlands and rocky canyonlands throughout the southwestern United States and Mexico (Johnson and Johnson 1985, MacDonald et al. 1991). In southern Utah, the Mexican subspecies is found primarily in rocky canyonlands and could be negatively impacted by land use practices unique to this region (MacDonald et al. 1991). GIS analysis of landscape patterns associated with the owl is necessary to identify important habitat, to provide information on potential impacts of management activities (e.g., timber harvest, mining, and recreation), and to develop ecologically based habitat conservation (Gutiérrez 1989).

This report presents the results of a geographical modelling exercise that described Mexican spotted owl habitat in Capitol Reef and Zion National Parks using the ARC/INFO GIS (ESRI 1992). The model was developed at the National Biological Service Colorado Plateau Research Station (CPRS) via a cooperative research agreement between the USDA Forest Service Rocky Mountain Forest and Range Experiment Station, and the CPRS at Northern Arizona University.

## OBJECTIVES

GIS model development had the following objectives:

1) Acquire a Digital Elevation Model (DEM) coverage in ARC/INFO that portrays topography in and around Capitol Reef and Zion national parks at the 1:24,000 map scale.

2) Acquire a vegetation coverage in ARC/INFO that portrays plant community distribution in and around Zion and Capitol Reef national parks at the 1:24,000 map scale.

3) Construct a Mexican spotted owl GIS layer in ARC/INFO using point locations of spotted owls generated by telemetry and inventory conducted in Capitol Reef and Zion national parks.

4) Conduct overlay analysis using vegetation, topography, and owl ARC/INFO layers ("covers") to describe landscape features of spotted owl sites in Capitol Reef national park.

5) Create a GIS model that identifies suitable roost/nest habitat in Capitol Reef National Park.

6) Test the generality of the Capitol Reef GIS model with a GIS data base developed for Zion national park.

## STUDY AREAS

Zion and Capitol Reef national parks occur within the High Plateaus and Canyonlands Sections of the Colorado Plateau physiographic province and consist of extensive sandstone canyons interspersed by salt valleys, upwarped plateaus and laccolithic mountain ranges (Barnes 1978, Hintze 1986, Thornbury 1965). Prolonged erosional dissection has produced a maze of complex watersheds within both geologic Sections (Youngblood and Mauk 1985). Elevations throughout the sections range from 1,109 t 3,960 m. Total annual precipitation averages 17 cm per year, and temperatures range seasonally from below 0 to 40 C (U.S. Weather Bureau, Climate and Precipitation Summaries, Utah).

Data on owl distribution were available from two areas in southern Utah within the Canyonlands Section: Zion National Park (ZION), and Capitol Reef National Park (CARE). ZION was located 1 km north of Springdale, in south-eastern Utah. The ZION site was characterized by steep sandstone canyons and slopes surrounded by high vertical cliffs and isolated mesas. Elevation ranged from 1,345 to 2,141 m. Vegetation along canyon bottoms was primarily mixed-conifer forest, with ponderosa pine *(Pinus ponderosa)* and pinyon pine (*P. edulis*)/Utah juniper (*Juniperus utahensis*) forests on slopes and mesa tops. Mixed-conifer forests were dominated by Douglas-fir (*Psuedotsuga menziesii*) and white fir (*Abies concolor*), typically with a component of Ponderosa pine, box elder (*Acer negundo*), and bigtooth maple (*A. grandidentatum*). Gambel oak (*Quercus gambelii*) was also found in the understory of ZION habitats.

The CARE site was located 25 km north-east of Torrey, in south-central Utah. CARE was characterized by deeply entrenched sandstone canyons eroded into the northern highlands of the Waterpocket Fold, a 160-km north-south tending monocline. High cliffs, slot canyons, and numerous caves were found throughout the canyons (Barnes 1978). Elevation ranged from 1,835 to 2,294 m. Vegetation within canyons varied, with patches of mixed-conifer and pinyon-juniper forest interspersed by stands of Fremont cottonwood (*Populus fremontii*) and willow (*Salix* spps.). Adjacent uplands were covered by pinyon-juniper woodland with Gambel oak present in the understory.

## METHODS

All active and historic Mexican spotted owl sites located within CARE and ZION were used to construct a GIS layer for each park using point locations where owls were actually seen or generated during telemetry triangulation (Willey 1993). Vegetation, topography, and geology layers were created using existing data sets (e.g., DEM) or by digitizing United States Geological Survey (USGS) maps (e.g., USGS Surface Geology map of ZION). Next, overlay analysis and landscape habitat modelling within the ARC/INFO GIS generated final predictive maps showing the distribution of potential spotted owl habitat within the parks.

### OBJECTIVES 1-3, GIS Layer acquisition

DEM layers at the 1:24,000 map scale were obtained from USGS for CARE and ZION and converted to ARC covers (see ESRI 1992). Vegetation covers, showing the distribution of broad vegetation communities, were obtained from ZION and CARE GIS staff (Jennifer Norton, pers. comm.). The vegetation covers were converted to ARC cover files at the CPRS (Paul Deshler, pers. comm.). Slope and Aspect ARC covers were created using the park DEMs. A Geology layer was available in ARC/INFO format for CARE; however, ZION surface geology was digitized by hand using ARC-EDIT and a digitizing table (ESRI 1992). The owl coverage was created using only nest and roost point locations generated in both parks during telemetry and inventory work conducted by Willey (1993).

## OBJECTIVE 4, CARE Overlay Analysis

The CARE data set, including the five ARC covers (i.e., slope, aspect, elevation, geology, vegetation, and owl), were overlayed using ARC-PLOT (ESRI 1992) to describe habitat surrounding spotted owl roost and nest sites. The CARE data layers were loaded into the ARC-PLOT workspace as interchange files and then transformed into covers. Spotted owl point locations (i.e., roost and nest sites) were then buffered by the average home-range size of spotted owls in the study areas (approximately 2000 ha; Willey 1993). The ARC buffer command generated attribute tables that described the spatial area contained within a 2000 ha area surrounding the owl point locations in terms of slope, aspect, vegetation, and surface geology (ESRI 1992). The buffer attribute tables were then inspected to summarize characteristics of landscape within 2000 ha of spotted owl roost and nest sites in CARE in order to develop criterion to rank all of CARE in terms of spotted owl habitat quality.

## OBJECTIVE 5: CARE Modelling

The ARC covers (i.e., slope, aspect, elevation, geology, vegetation, and owl) were overlayed using ARC-PLOT and then ranked in terms of habitat quality with the ARC/INFO Simple Macro Language (SML; ESRI 1992). Habitat quality was based upon the results of the initial overlay analysis and inspection of the 2000 ha buffers. For example, inspection of the buffer attribute

tables indicated that landscape surrounding spotted owl point locations (i.e., roost and nest sites) was dominated by woodland vegetation, cliff forming geologic layers (particularly the Wingate-Kayenta Sandstone layer interface), moist soil layers, north facing aspects, and steep slopes. Therefore, the SML was used to rank the CARE landscape from not suitable to highly suitable based on distribution of optimal polygons that contained high quality categories. For example, highly suitable areas possessed 4-5 optimal features (i.e. woodland vegetation, cliff layers, moist soil layers, north facing aspects, and steep slopes); whereas, marginal areas possessed 2-3 optimal features. Non suitable areas possessed less than 2 optimal features. This procedure allowed the entire park to be ranked in terms of habitat suitability for spotted owls.

## OBJECTIVE 6, Model Testing

The SML GIS model developed to rank habitat suitability for spotted owls in CARE was applied to the ZION data set to rank the ZION landscape. The geology layer was modified in ZION to include the Temple Cap-Navajo and Navajo-Kayenta geologic formation interfaces because these areas included abundant caves, ledges, and springs in the ZION study area. After the model was run on the ZION data and a predictive map generated, all 29 ZION spotted owl territories (both nest sites and sites where spotted owls were detected during inventory) were plotted on the predictive map to test the models success in capturing known owl locations.

## RESULTS AND DISCUSSION

The ARC-PLOT overlay analyses resulted in the description of suitable spotted owl nest and roost habitat as those areas characterized by sandstone canyons with woodland vegetation (dwarf woodland, mixed-conifer, deciduous woodland), steep north-facing slopes, in areas with large cliffs (particularly at the Wingate-Kayenta sandstone layer interface), and with moist soil types. These habitat features were used to rank overlayed data layers in terms of habitat quality for spotted owls in CARE and ZION. The final CARE and ZION predictive maps portrayed highly suitable roost/nest habitat found within the two parks (Figs. 1 & 2). The modified CARE model performed very well in ZION, capturing 76% of the known spotted owl sites located in the park (Fig. 2).

The GIS models (Figs. 1 & 2) resulted in the identification of large areas (i.e., landscape patches) of suitable nest and roost habitat in the parks. Suitable habitat included areas with deeply eroded sandstone canyons and woodland vegetation. The geology layer (particularly the interfaces between geologic strata) provided the best criteria for habitat ranking.

The landscape criterion used in the CARE and ZION predictive models matched features of owl sites described by Willey (1993), where owls were found using areas with large north-facing cliffs, ledges and caves, and adjacent to woodland vegetation. Ganey and Balda (1989b) and Gutiérrez (1989) described Mexican spotted owl sites in canyons with high vertical relief and relatively dense

vegetation cover, frequently in mixed conifer vegetation. Together, these studies support the idea that spotted owl occupy complex habitats within the overall landscape (Gould 1977).

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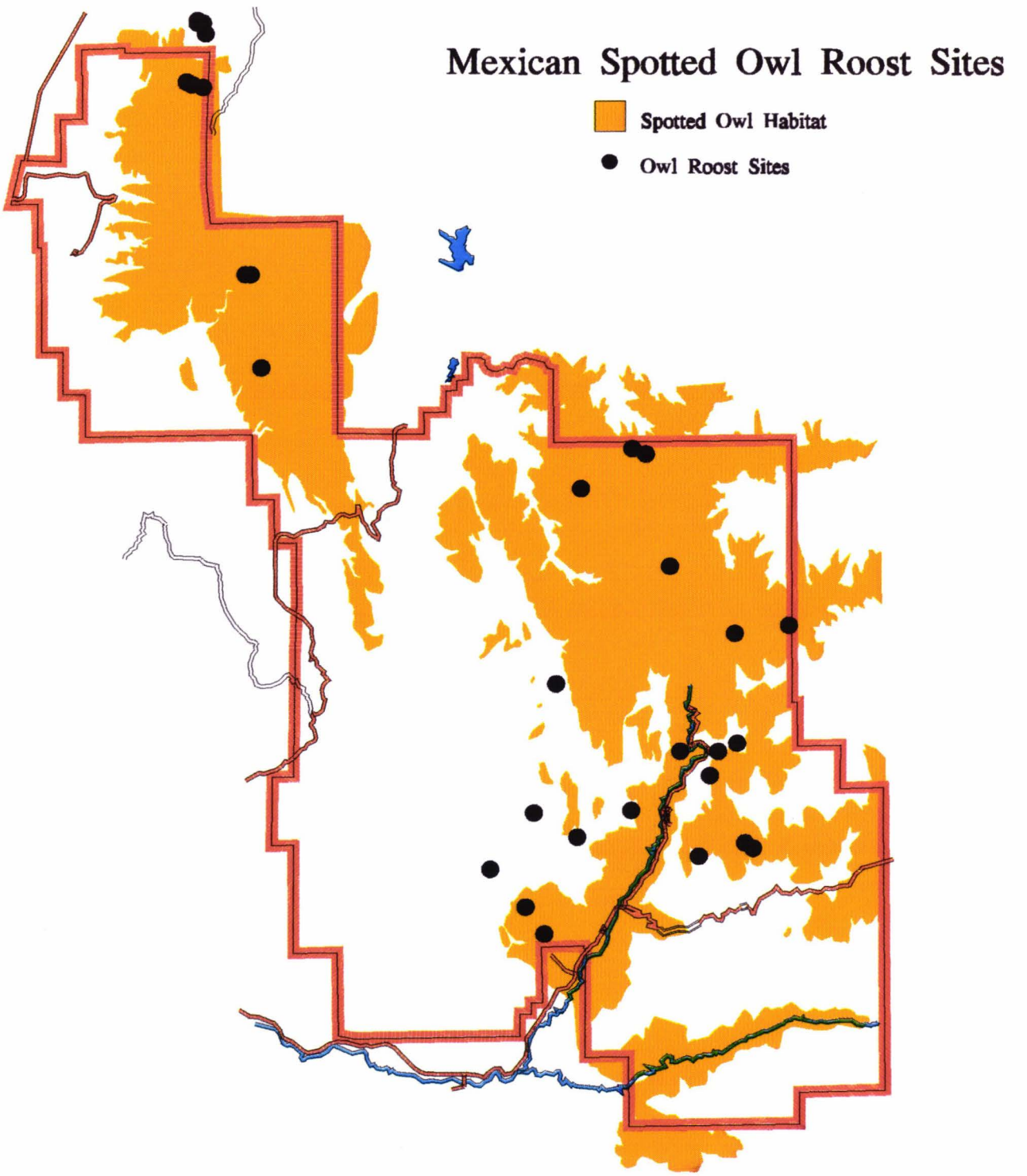
**FIGURE 1.** Final habitat model showing suitable roosting habitat for Mexican spotted owls in Capitol Reef National Park.

**FIGURE 2.** Final habitat model showing suitable roosting habitat for Mexican spotted owls in Zion National Park.


Mexican Spotted Owl Roost Sites
Spotted Owl Habitat
Owl Roost Sites

# Mexican Spotted Owl Roost Sites

Spotted Owl Habitat

Owl Roost Site

1 inch = 2 miles

# Capitol Reef National Park

## LITERATURE CITED


Barnes, F. A. 1978. Canyon Country Geology. Wasatch Publications Inc., Salt Lake City. 160pp.

Carey, A. B., J. A. Reid, and S. P. Horton. 1990. Spotted owl home range and habitat use in southern coast ranges. J. Wildl. Manage. 54:11-17.

ESRI. 1992. ARC/INFO. Environmental Systems Research Inst., Inc. ARC version 6.1 (June 30, 1992). Redlands, CA.

Forsman, E.D., E. C. Meslow and H. M. Wight. 1984. Distribution and biology of the spotted owl in Oregon. Wildl. Monogr. 87. 64pp.

Franklin, A. B., J. P. Ward, R. J. Gutierrez, and G. I. Gould, Jr. 1990. Density of northern spotted owls in northwest California. J. Wildl. Manage. 54:1-10.

Ganey, J. L. 1991. Developing and testing a predictive model for Mexican spotted owl habitat. Dissertation, Northern Arizona University.

Ganey, J. L., and R. P. Balda. 1989a. Distribution and habitat use of Mexican spotted owls in Arizona. Condor 91:355-361.

Ganey, J. L., and R. P. Balda. 1989b. Home range characteristics of spotted owls in northern Arizona. J. Wildl. Manage. 53:1159-1165.

Gould, G. I. 1977. Distribution of the spotted owl in California. West. Birds 8:131-146.

Gutiérrez, R. J. 1989. Distribution and abundance of spotted owls in Zion National Park. NPS order No. PX-1200-9-C820. Annual Report. 17pp.

Hintze, L. F. 1986. Geologic History of Utah. Univ. Press, Dept. of Geology, BYU. 181pp.

Johnson, J. A., and T. H. Johnson. 1985. The status of the spotted owl in northern New Mexico. New Mexico Dep. Game and Fish. Santa Fe, NM. Contract No. 516.6-73-03. 39pp.

McDonald, C.B., J. Andersen, J.C. Lewis, R. Mesta, A. Ratzliff, T.J. Tibbots, and S.O. Williams III. 1990. Mexican Spotted Owl Status Review. US Fish and Wildlife Service. Department of the Interior. 85pp.

Murphy, D. D., and B. R. Noon. 1992. Integrating scientific methods with habitat conservation planning: Reserve design for northern spotted owls. Ecol. Applic. 2:3-17.

Salwasser, H. 1987. Spotted owls: Turning a battleground into a blueprint. Ecology 68:776-779.

Shaffer, M. L. 1985. The metapopulation and species conservation the special case of the northern spotted owl. Pages 86-99 In: R.J. Gutierrez and A.B. Carey [eds.], The Ecology and management of the spotted owl in the Pacific Northwest. USDA For. Serv. Gen. Tech. Rep. PNW-185, Portland, Oregon.

Shaw, D. M., and S. F. Atkinson. 1990. An Introduction to the use of Geographic Information Systems for Ornithological Research. Condor 92:564-570.

Thornbury, W. 1965. Regional geomorphology of the United States. John Wiley and Sons, New York. 609pp.

Verner, J. V., M. L. Morrison, and C. J. Ralph. 1986. Wildlife 2000. Univ. Wisconsin Press. Madison, Wisconsin. 470pp.

Willey, D.W. 1993. Home-range and habitat Characteristics and Juvenile dispersal ecology of Mexican Spotted Owls in southern Utah. Unpublished tech. rep. Utah Division of Wildlife Resources, Contract No. 91-2577.

Youngblood, A.P., and R.L. Mauk. 1985. Coniferous forest habitat types of central and southern Utah. USDA For. Serv. Gen. Tech. Rep. INT-187.